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TRENDS IN EX-VESSEL VALUE AND SIZE COMPOSITION OF REPORTED MAY–AUGUST CATCHES OF BROWN SHRIMP AND WHITE SHRIMP FROM THE TEXAS, LOUISIANA, MISSISSIPPI, AND ALABAMA COASTS, 1960–1978[1]

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ABSTRACT Exponential models were used to characterize (1) ex-vessel value (in dollars) per shrimp by size category (count; i.e., number of shrimp per pound, heads off); (2) size composition (expressed as cumulative weight of the catch in pounds, heads off, by size category); and (3) ex-vessel value composition (expressed as cumulative ex-vessel value, in dollars, of the catch by size category) for reported May–August catches (inshore and offshore combined) of brown shrimp (*Penaeus aztecus*) and white shrimp (*P. setiferus*) from the Texas, Louisiana, Mississippi, and Alabama coasts (statistical areas 10–21) from 1960 to 1978. Exponents of the models were used as indices to investigate trends in ex-vessel value per shrimp, size composition, and ex-vessel value composition of the May–August catches during this period. This approach to analysis of catch statistics can be used to monitor these fisheries, and the results can be compared with changes that may be brought about by the closure of the fishery conservation zone off Texas, as proposed by 1981 by the Gulf of Mexico Fishery Management Council, in the fishery management plan for the shrimp fishery of the Gulf of Mexico.

INTRODUCTION

The fishery management plan for the shrimp fishery of the Gulf of Mexico, prepared by the Gulf of Mexico Fishery Management Council (GMFMC 1980), proposed a simultaneous closing of the territorial sea of the State of Texas and the adjacent fishery conservation zone (FCZ) to shrimping during the time of the year when brown shrimp (*Penaeus aztecus*) in these waters are, for the most part, smaller than 65 count (refers throughout this paper to number of shrimp per pound, heads removed). The territorial sea is the area under state jurisdiction extending from the coastal baseline to 9 nautical miles off Texas (Figure 1). The FCZ is the area under federal jurisdiction beginning at the outer limit of Texas' territorial sea and extending 200 miles from shore. The closing of Texas' territorial sea to shrimping normally begins June 1 and extends to July 15. However, a 15-day flexibility in the closing and opening dates is allowed to accommodate effects of climatic variations on shrimp growth, within the restriction that the period of closure does not exceed 60 days. The inclusive dates for the closure in 1981 were May 22–July 15. The management plan encouraged the State of Texas to continue its seasonal closure of the territorial sea, to eliminate minimum size restrictions on shrimp caught in open waters before and after the closure, and to evaluate the effect of allowing white shrimp (*P. setiferus*) fishing to continue within the closed areas during the closure.

Rationale for the proposed closure was an expected increase in yield from additional growth of the protected brown shrimp, and from the elimination of waste due to discarding of undersized brown shrimp in the FCZ (GMFMC 1980). The management plan recognized that the closure might affect other fishing areas (e.g., the coasts of Louisiana, Mississippi, and Alabama) by shifting fishing effort to those areas. Therefore, it was the intent of the management plan that the biological, ecological, social and economic impacts of the closure be monitored in 1981 so that revisions could be made if warranted.

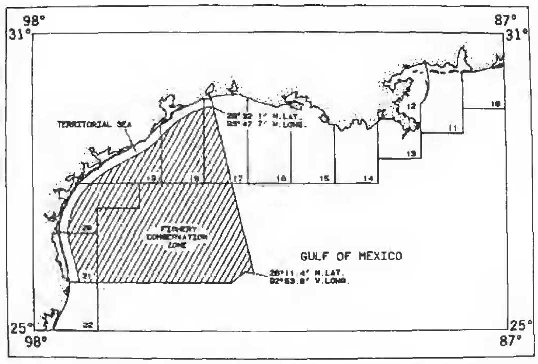

Figure 1. Boundaries of statistical areas 10–21, the Texas territorial sea, and the fisheries conservation zone off Texas (based on information from GMFMC 1980).

As might be expected, the proposed closure of the FCZ off Texas has become a highly controversial issue. There is considerable interest and concern on the part of the fishing industry, the Gulf states, the GMFMC, the National Marine Fisheries Service (NMFS), and fishery scientists regarding the potential impacts of the proposed closure.

We expect that the redistribution of fishing effort, the changes in fishing strategy, and the additional shrimp growth that may result from the closure will cause changes in size composition of the combined inshore and offshore catch.

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Inshore waters generally are considered to be landward of the barrier islands, and are represented by bays or estuaries. Offshore waters are seaward of the barrier islands. According to Henderson (1972) and Ricker (1975), an increase in average size of individuals in the catch could indicate a decrease in mortality (usually equated with a decrease in fishing mortality) or an increase in growth (e.g., if recruitment were poor, and if population density were low as a consequence). A decrease in average size might be brought about after the closure by retention and landing of large quantities of small shrimp, previously discarded at sea. Also a decrease in average size might be caused by an intensification of fishing in offshore and inshore waters open to shrimping in other areas during the closure. Socioeconomic factors leading to changes in strategies of fishing, culling of the catch, and marketing of the landings also could influence size composition of the catch.

Caillouet et al. (1980) developed a simple exponential model to characterize the size composition (expressed as cumulative percentage of weight of catch by size category) of annual catches of shrimp. They showed that the size of brown and white shrimp in the reported annual catches from Texas and Louisiana decreased from 1959 to 1976. Caillouet and Koi (1980) modified the model by applying it to cumulative weight by size category instead of cumulative percentage of weight by size category, and used it to investigate trends in size composition of the annual landings of brown, pink (*P. duorarum*), and white shrimp from the Gulf and southeast coast fisheries of the United States from 1961 to 1977. Caillouet and Koi (1980) also used exponential models to investigate trends in ex-vessel value per shrimp by size category, size composition, and ex-vessel value composition of these annual landings. Using the methods of Caillouet and Koi (1980), Caillouet and Koi (1981) investigated trends in ex-vessel value per shrimp by size category, size composition, and ex-vessel value composition of reported annual catches of pink shrimp from the Tortugas fishery off south Florida from 1960 to 1978. The effect of shrimp size on the ex-vessel value of the catch has also been recognized by Neal (1967), Griffin et al. (1974), Griffin and Nichols (1976), and Griffin et al. (1976).

The NMFS has the responsibility for monitoring impacts of closing the FCZ off Texas. The purposes of this paper are to propose a procedure for monitoring the brown and white shrimp fisheries of Texas, Louisiana, Mississippi, and Alabama, based on the methods of Caillouet and Koi (1980), and to use these methods to investigate trends in ex-vessel value per shrimp by size category, size composition and ex-vessel value composition of the reported May–August catches from 1960 to 1978. This approach can then be used as one means of assessing the impacts of closing the FCZ off Texas in 1981. The period May-August was chosen for these analyses to assure that the period of closure of Texas' territorial sea and the FCZ would be encompassed, considering the allowed flexibility in the starting and ending dates for the closure. Including May and August in the time interval of coverage for the years 1960–1978 will assure that some catch statistics will be available from the Texas coast for future comparison with those from Louisiana, Mississippi, and Alabama for the May-August period in 1981.

DESCRIPTION OF DATA

Summaries of the May–August catches of brown and white shrimp and their ex-vessel value were compiled from data files available from the NMFS, Southeast Fisheries Center (SEFC) Technical and Information Management Services (TIMS), Miami, Florida. The combined weight of the reported May-August catches (inshore and offshore combined) was expressed in pounds (heads off) and the ex-vessel value in dollars, by year (1960–1978); coastal area (statistical areas 10–12, 13–17, and 18–21, Figure 1); species (brown and white shrimp); and size category ($<$ 15, 15–20, 21–25, 26–30, 31–40, 41–50, 51–67, and $\geqslant$ 68 count, and "pieces," representing parts of shrimp tails that could not be assigned to a count category). Comparable data for the years 1979 through 1981 were not available at the time of this writing.

The three coastal areas are defined as (1) Texas coast (statistical areas 18–21 combined); (2) Mississippi River to Texas (statistical areas 13–17 combined), representing that part of the Louisiana coast west of the Mississippi River; and (3) Pensacola to the Mississippi River (statistical areas 10–12 combined), representing that part of the Louisiana coast east of the Mississippi River, the Mississippi coast, the Alabama coast, and a small part of the upper coast of Florida (catches from Pensacola Bay are not included in this area; they are allocated to the adjacent Apalachicola area by TIMS). Note that part of statistical area 17 is included in the area that was closed in 1981 (Figure 1). Therefore, for the years 1960 to 1978, the May–August catch statistics for the Mississippi River to Texas coastal area represent a somewhat larger zone open to shrimping than was the case in 1981, as a result of the closure. This should be considered in any future analyses applying our methods to data for the Mississippi River to Texas coastal area.

English rather than metric units are used throughout our paper because they have been used historically, and information would have been lost in their conversion to metric units. Catches used herein represent those portions of the actual catches that were landed by domestic commercial fishermen at domestic ports and reported by the National Marine Fisheries Service or its predecessor, the Bureau of Commercial Fisheries, U.S. Fish and Wildlife Service.

ANALYSES AND RESULTS

May–August Catches by Year

The general trends in reported May–August catches, and their ex-vessel value for both species and the three coastal areas are shown in Figures 2 through 7. In each coastal area, the catch of brown shrimp exceeded that of white shrimp. The general trends in catch were upward, except for white shrimp from Pensacola to the Mississippi River (Figure 7) for which the trend was downward. In all cases, the general trend in ex-vessel value of the catch was upward, but this was not adjusted to account for inflation.

May–August Ex-vessel Value per Shrimp by Size Category

We calculated the May–August average ex-vessel value per shrimp, V, by size category, C, for each year, according to the methods of Caillouet and Koi (1980, 1981), to obtain the following exponential model which described the relationship between V_i and C_i for each species, coastal area, and year:

$$\hat{V}_i = a\,(\exp bC_i) \qquad (1)$$

where V_i = May–August average ex-vessel value per shrimp for the ith size category; C_i = lower limit (count) of the ith size category ($C_1 = 15, C_2 = 21, C_3 = 26, C_4 = 31, C_5 = 41, C_6 = 51$, and $C_7 = 68$); and $i = 1, 2, \ldots, 7$. The logarithmic form of model 1 was used to estimate parameters a and b by linear regression (Tables 1 through 3). The very high coefficients of determination, r^2, indicated that the straight lines fitted the data very well. All slopes, b, were negative, showing that the value per

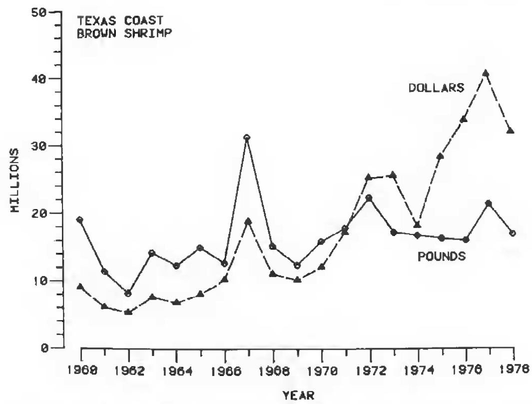

Figure 2. Weight (millions of pounds, heads off) and ex-vessel value (millions of dollars) of reported May–August catches (inshore and offshore combined) of brown shrimp from the Texas coast (statistical areas 18–21 combined), 1960–1978.

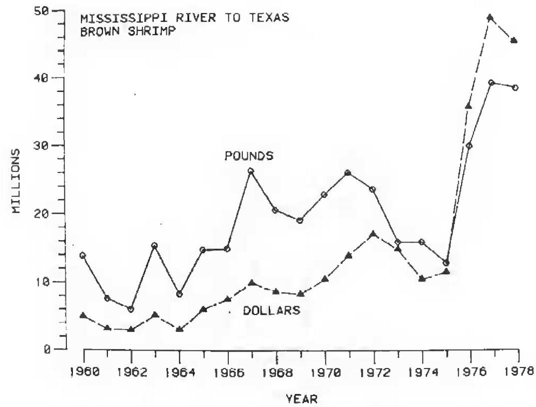

Figure 4. Weight (millions of pounds, heads off) and ex-vessel value (millions of dollars) of reported May–August catches (inshore and offshore combined) of brown shrimp from the Mississippi River to Texas (statistical areas 13–17 combined), 1960–1978.

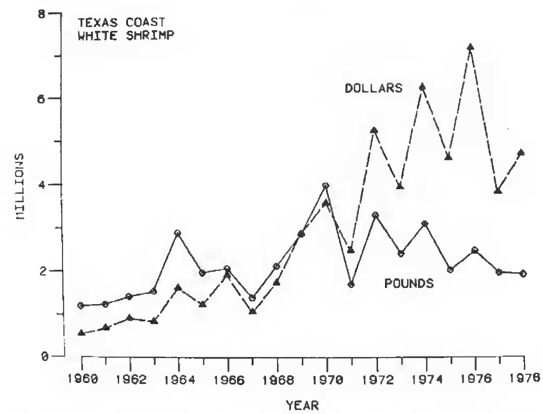

Figure 3. Weight (millions of pounds, heads off) and ex-vessel value (millions of dollars) of reported May–August catches (inshore and offshore combined) of white shrimp from the Texas coast (statistical areas 18–21 combined), 1960–1978.

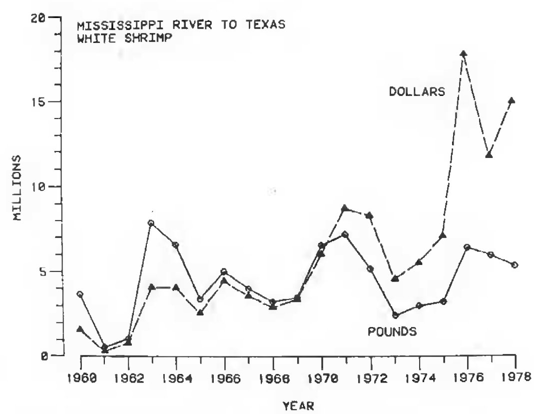

Figure 5. Weight (millions of pounds, heads off) and ex-vessel value (millions of dollars) of reported May–August catches (inshore and offshore combined) of white shrimp from the Mississippi River to Texas (statistical areas 13–17 combined), 1960–1978.

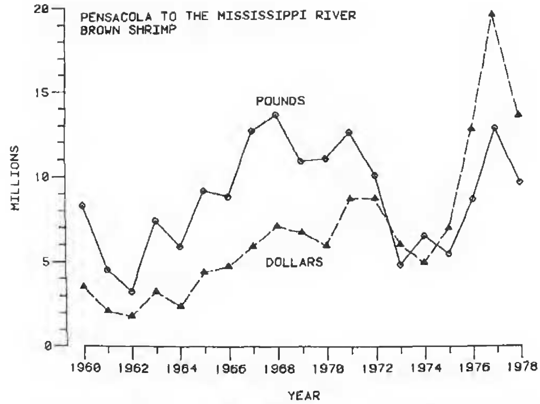

Figure 6. Weight (millions of pounds, heads off) and ex-vessel value (millions of dollars) of reported May–August catches (inshore and offshore combined) of brown shrimp from Pensacola to the Mississippi River (statistical areas 10–12 combined), 1960–1978.

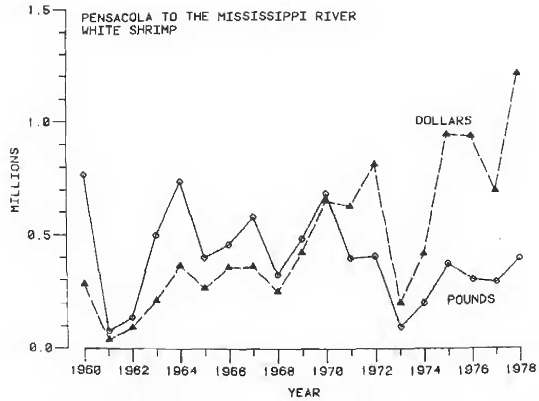

Figure 7. Weight (millions of pounds, heads off) and ex-vessel value (millions of dollars) of reported May–August catches (inshore and offshore combined) of white shrimp from Pensacola to the Mississippi River (statistical areas 10–12 combined), 1960–1978.

TABLE 1.

Relationship between transformed ex-vessel value (dollars) per shrimp, lnV, and count, C, for reported May-August catches (inshore and offshore combined) of brown and white shrimp from the Texas coast (statistical areas 18–21 combined), 1960–1978.*

Year	Brown Shrimp			White Shrimp		
	a	b	r^2	a	b	r^2
1960	0.07492	−0.04629	0.966	0.07379	−0.04900	0.939
1961	0.08534	−0.04876	0.992	0.07594	−0.04376	0.992
1962	0.12142	−0.04926	0.994	0.11820	−0.05124	0.985
1963	0.11596	−0.05782	0.987	0.09864	−0.05236	0.957
1964	0.09822	−0.05076	0.985	0.09053	−0.04974	0.980
1965	0.11088	−0.05347	0.989	0.09313	−0.04807	0.982
1966	0.15149	−0.05204	0.986	0.12842	−0.04775	0.993
1967	0.11772	−0.05380	0.981	0.11758	−0.05076	0.957
1968	0.16950	−0.05686	0.983	0.12651	−0.04732	0.926
1969	0.18600	−0.05580	0.992	0.19635	−0.06037	0.995
1970	0.17010	−0.05730	0.988	0.15597	−0.05546	0.979
1971	0.25218	−0.05918	0.987	0.19029	−0.04982	0.981
1972	0.26745	−0.05896	0.992	0.27621	−0.05965	0.985
1973	0.30651	−0.05136	0.993	0.23322	−0.04344	0.996
1974	0.29912	−0.06135	0.962	0.31702	−0.06005	0.968
1975	0.37610	−0.05334	0.995	0.36948	−0.05330	0.997
1976	0.59955	−0.06131	0.982	0.57544	−0.05680	0.989
1977	0.51261	−0.05869	0.981	0.53091	−0.05931	0.968
1978	0.59723	−0.05899	0.996	0.41271	−0.04753	0.967

*Based on the linear regression of lnV on C, where V = May-August average ex-vessel value per shrimp in each of seven size categories, C = lower limit (count) of each of the seven size categories, ln(a) = intercept, b = slope, and r^2 = coefficient of determination; all slopes, b, were significantly different from 0 at the 99% level of confidence, and the high r^2 values indicated a very good fit of the straight lines to the data points.

TABLE 2.

Relationship between transformed ex-vessel value (dollars) per shrimp, lnV, and count, C, for reported May-August catches (inshore and offshore combined) of brown and white shrimp from the Mississippi River to Texas (statistical areas 13–17 combined), 1960–1978.*

Year	Brown Shrimp			White Shrimp		
	a	b	r^2	a	b	r^2
1960	0.07177	−0.04518	0.960	0.08062	−0.04922	0.950
1961	0.07807	−0.04540	0.976	0.07230	−0.04069	0.987
1962	0.10589	−0.04496	0.982	0.10262	−0.04317	0.964
1963	0.10710	−0.05525	0.979	0.11971	−0.05634	0.954
1964	0.09336	−0.05032	0.977	0.08392	−0.04693	0.958
1965	0.09448	−0.04770	0.980	0.09079	−0.04550	0.975
1966	0.13860	−0.04983	0.993	0.11432	−0.04402	0.977
1967	0.11373	−0.05142	0.978	0.13192	−0.05004	0.967
1968	0.16711	−0.05673	0.983	0.15812	−0.05335	0.974
1969	0.18027	−0.05456	0.993	0.16861	−0.05167	0.982
1970	0.16396	−0.05586	0.983	0.15779	−0.05146	0.979
1971	0.26244	−0.06079	0.991	0.22663	−0.05676	0.988
1972	0.25174	−0.05603	0.991	0.27206	−0.05543	0.981
1973	0.28208	−0.04830	0.996	0.23883	0.04253	0.991
1974	0.31893	−0.06200	0.963	0.34038	−0.06098	0.953
1975	0.44343	−0.05921	0.998	0.39411	−0.05521	0.997
1976	0.54890	−0.05990	0.990	0.64588	−0.06011	0.992
1977	0.50268	−0.05870	0.979	0.51734	−0.05844	0.971
1978	0.55672	−0.05896	0.998	0.47111	−0.05203	0.990

*Based on the linear regression of lnV on C, where V = May-August average ex-vessel value per shrimp in each of seven size categories, C = lower limit (count) of each of the seven size categories, ln(a) = intercept, b = slope, and r^2 = coefficient of determination; all slopes, b, were significantly different from 0 at the 99% level of confidence, and the high r^2 values indicated a very good fit of the straight lines to the data points.

TABLE 3.

Relationship between transformed ex-vessel value (dollars) per shrimp, lnV, and count, C, for reported May-August catches (inshore and offshore combined) of brown and white shrimp from Pensacola to the Mississippi River (statistical areas 10–12 combined), 1960–1978.*

Year	Brown Shrimp			White Shrimp		
	a	b	r^2	a	b	r^2
1960	0.06459	−0.04092	0.950	0.07132	−0.04533	0.954
1961	0.06892	−0.04052	0.953	0.06839	−0.03821	0.965
1962	0.09940	−0.04296	0.953	0.09536	−0.04022	0.962
1963	0.08738	−0.04806	0.951	0.09655	−0.05245	0.950
1964	0.08482	−0.04654	0.963	0.08617	−0.04676	0.977
1965	0.08664	−0.04376	0.956	0.08619	−0.04278	0.944
1966	0.12705	−0.04682	0.986	0.11061	−0.04302	0.956
1967	0.09783	−0.04687	0.952	0.12206	−0.05243	0.929
1968	0.15802	−0.05362	0.974	0.14762	−0.05040	0.963
1969	0.16800	−0.05224	0.981	0.14203	−0.04660	0.940
1970	0.14682	−0.05182	0.966	0.14364	−0.05006	0.951
1971	0.24106	−0.05768	0.982	0.21810	−0.05502	0.984
1972	0.23786	−0.05198	0.974	0.03587	0.01917†	0.063†
1973	0.29481	−0.04925	0.991	0.25034	−0.04056	0.995
1974	0.31528	−0.05927	0.968	0.34052	−0.06087	0.943
1975	0.38841	−0.05390	0.996	0.34995	−0.05095	0.987
1976	0.54194	−0.05741	0.980	0.54105	−0.05609	0.966
1977	0.47724	−0.05660	0.967	0.50089	−0.05739	0.977
1978	0.50039	−0.05555	0.995	0.43380	−0.04895	0.987

*Based on the linear regression of lnV on C, where V = May-August average ex-vessel value per shrimp in each of seven size categories, C = lower limit (count) of each of the seven size categories, ln(a) = intercept, b = slope, and r^2 = coefficient of determination; all slopes, b, except one, were significantly different from 0 at the 99% level of confidence, and the high r^2 values indicated a very good fit of the straight lines to the data points.

†The slope, b, for white shrimp in 1972 did not differ significantly from 0 at the 95% level of confidence, and the r^2 value was very low, because no catch was reported for the ⩾ 68 count category.

shrimp decreased with increase in count (decrease in size), as expected.

Lower limits rather than midpoints or upper limits of the seven size categories were used in constructing model 1, as in Caillouet and Koi (1980, 1981). The < 15 category represented ⩽ 3% of the May–August catches of brown shrimp in each of the three coastal areas in any given year. However, for white shrimp, the < 15 category represented as high as 23% of the May–August catches from the Texas coast, 15% from the Mississippi River to Texas, and 28% from Pensacola to the Mississippi River in certain years. We did not include the < 15 size category in model 1 to be consistent with previous work, and because the logarithmic form of model 1 is not a straight line in the region of < 15 count (Caillouet and Koi 1980, 1981; Caillouet et al. 1980). The category "pieces" was excluded from the model because it represented parts of shrimp tails which could not be assigned to a count category. The constant, a, reflected the elevation of the straight line which was influenced in part by our use of lower limits of size categories and exclusion of the < 15 size category in fitting the model. The slope, b, of the straight line is a simple index of the ex-vessel price spread among the size categories of shrimp, i.e., it is an index of ex-vessel price structure.

There were significant downward trends in b for brown shrimp in all three coastal areas, and for white shrimp in all coastal areas except the Texas coast from 1960 to 1978 (Table 4). For white shrimp from the Texas coast, the general trend was downward, but it was not statistically significant. The downward trends indicated that the May–August ex-vessel price spread among the size categories of shrimp increased from 1960 to 1978. Whitaker (1973) also observed an increase in price spread between large and small "southern" shrimp during the period from 1957 to 1971. The data point for 1972 was excluded from calculation of the trend for white shrimp from Pensacola to the Mississippi River because no catch was reported for the ⩾ 68 count category in 1972 and, therefore, the fit of the model was poor (Table 3).

May–August Cumulative Catch by Size Category

We calculated the cumulative weight, P, of the May August catch in each of the same seven size categories, for each species, coastal area, and year (see Caillouet and Koi 1980, 1981). These catches were cumulated, starting with the size category of smallest shrimp (highest count, ⩾ 68) and continuing toward the size category of largest shrimp (lowest count, 15–20). The following exponential model described the relationship between P_i and C_i for each species, coastal area, and year:

$$\hat{P}_i = c\,(\exp dC_i) \qquad (2)$$

where P_i = cumulative weight of the May–August catch in the ith size category. The logarithmic form of model 2 was used to estimate parameters c and d by linear regression (Tables 5 through 7). The coefficients of determination for the straight lines were very high. All slopes, d, were negative, which reflected the construction of model 2 by cumulating catches from small- to large-shrimp size categories (see Caillouet and Koi 1980, 1981).

There were significant upward trends in d for brown shrimp, but no significant trends in d for white shrimp, in all three coastal areas from 1960 to 1978 (Table 4). The upward trends indicated that the size of brown shrimp in the reported May–August catches decreased from 1960 to 1978. The values of d for brown and white shrimp from the Texas coast (Table 5) were lower than those from the other two coastal areas (Tables 6 and 7), indicating that the shrimp in the May–August catch from the Texas coast generally were larger than those in the other two coastal areas. The data point for 1972 was excluded from calculation of the trend for white shrimp from Pensacola to the Mississippi River (Table 7) as in the previous section.

TABLE 4.

Trends in ex-vessel value (dollars) per shrimp by size category, in cumulative catch (pounds, heads off) by size category, and in cumulative ex-vessel value (dollars) of catch by size category, for reported May–August catches (inshore and offshore combined) of brown and white shrimp from the Texas coast, the Mississippi River to Texas, and Pensacola to the Mississippi River during 1960–1978 (based on data from Tables 1–3, 5–7 and 9–11).

Species	Coastal Area		For ex-vessel value per shrimp by size category	For cumulative catch by size category	For cumulative ex-vessel value of catch by size category
Brown Shrimp	Texas Coast	Trends[1]	–0.0006[2]	0.0024[2]	0.0022[2]
		Trend coefficients of determination	0.532	0.560	0.505
Brown Shrimp	Mississippi River to Texas	Trends	–0.0008[2]	0.0003[2]	0.0001
		Trend coefficients of determination	0.632	0.362	0.030
Brown Shrimp	Pensacola to Mississippi River	Trends	–0.0009[2]	0.0010[2]	0.0006
		Trend coefficients of determination	0.770	0.405	0.191
White Shrimp	Texas Coast	Trends	–0.0004	0.0003	–0.0001
		Trend coefficients of determination	0.179	0.006	0.000[3]
White Shrimp	Mississippi River to Texas	Trends	–0.0007[2]	0.0009	0.0003
		Trend coefficients of determination	0.378	0.160	0.017
White Shrimp	Pensacola to Mississippi River	Trends	–0.0007[2]	–0.0006	–0.0015[4]
		Trend coefficients of determination	0.365	0.086	0.294

[1] Represents slopes of the linear regressions of b, d, and h, respectively, on x, where x represents the last two digits of each year, 1960–1978. The values b, d, and h are defined in Tables 1–3, 5–7, and 9–11, respectively. Data for 1972 were excluded from regressions for white shrimp from Pensacola to the Mississippi River (see Tables 3, 7, and 11).

[2] The trend (slope) was significantly different from 0 at the 99% level of confidence.

[3] Indicates >0.000 but ⩽0.005, which would not round to 0.001.

[4] The trend (slope) was significantly different from 0 at the 95% level of confidence.

There were no significant correlations between the weight of the May–August catch (including "pieces," Figures 2 through 7) each year and corresponding levels of d (Table 8). A lack of correlation suggested that size composition was not the major factor affecting the weight of the May–August catch. This would be expected if another factor (e.g., year-to-year variations in recruitment) played a larger role than changes in size composition in determining variations in weight of the May–August catch.

May–August Cumulative Ex-vessel Value of Catch by Size Category

For each species, coastal area, and year, we calculated the cumulative ex-vessel value, D, of the catch in each of the seven size categories, starting with the size category of smallest shrimp and cumulating toward the size category of largest shrimp (see Caillouet and Koi 1980, 1981).

The following exponential model described the relationship between D_i and C_i for each species, coastal area, and year:

$$\hat{D}_i = g\,(\exp hC_i) \qquad (3)$$

where D_i = cumulative ex-vessel value of catch in the ith size category. The logarithmic form of model 3 was used to estimate parameters g and h by linear regression (Tables 9 through 11). Very good fits were indicated by the very high coefficients of determination. All slopes, h, were negative, reflecting the construction of model 3 by cumulating ex-vessel value of catch from small- to large-shrimp size categories.

Only the upward trend in h for brown shrimp from the Texas coast and the downward trend in h for white shrimp from Pensacola to the Mississippi River from 1960 to 1978 were statistically significant (Table 4). The upward trend for brown shrimp from the Texas coast indicated that the proportions of the ex-vessel value of the May–August catch represented by the size categories of smaller shrimp increased from 1960 to 1978. The downward trend for white shrimp from Pensacola to the Mississippi River indicated that the proportions of the ex-vessel value of the May–August catch represented by the size categories of larger shrimp increased from 1960 to 1978. The data point for 1972

TABLE 5.

Relationship between transformed cumulative weight (pounds, heads off) of catch, lnP, and count, C, for reported May–August catches (inshore and offshore combined) of brown and white shrimp from the Texas coast (statistical areas 18–21 combined), 1960–1978.*

	Brown Shrimp			White Shrimp		
Year	c	d	r^2	c	d	r^2
1960	183,811,255	−0.10258	0.934	7,182,658	−0.08253	0.783
1961	48,575,993	−0.07323	0.960	1,873,296	−0.03948	0.975
1962	23,996,295	−0.04965	0.922	2,666,134	−0.03786	0.951
1963	53,600,556	−0.06741	0.966	6,724,244	−0.07125	0.942
1964	42,618,117	−0.06161	0.971	5,706,520	−0.04442	0.991
1965	39,567,158	−0.04776	0.967	2,765,052	−0.03578	0.974
1966	36,003,258	−0.05231	0.963	3,536,330	−0.05257	0.959
1967	120,211,109	−0.06731	0.963	1,559,694	−0.03168	0.976
1968	88,261,098	−0.07819	0.926	3,392,237	−0.03486	0.896
1969	42,957,422	−0.05614	0.918	7,858,608	−0.06541	0.992
1970	44,769,157	−0.05286	0.968	8,412,422	−0.05276	0.976
1971	52,564,419	−0.05110	0.941	4,334,297	−0.08055	0.998
1972	87,278,961	−0.06344	0.948	7,807,770	−0.06981	0.966
1973	37,018,191	−0.03611	0.938	3,725,606	−0.03378	0.943
1974	47,553,217	−0.05093	0.964	8,407,460	−0.08301	0.972
1975	36,279,377	−0.03871	0.958	6,147,586	−0.07249	0.991
1976	33,851,030	−0.03720	0.971	3,487,480	−0.03433	0.991
1977	46,903,835	−0.03852	0.966	2,876,486	−0.02481	0.956
1978	29,219,592	−0.02498	0.934	4,231,047	−0.04206	0.946

*Based on the linear regression of lnP on C, where P = cumulative weight of May-August catch in each of seven size categories, C = lower limit (count) of each of the seven size categories, ln(c) = intercept, d = slope, and r^2 = coefficient of determination; all slopes, d, were significantly different from 0 at the 99% level of confidence, and the high r^2 values indicated a very good fit of the straight lines to the data points.

TABLE 6.

Relationship between transformed cumulative weight (pounds, heads off) of catch, lnP, and count, C, for reported May–August catches (inshore and offshore combined) of brown and white shrimp from the Mississippi River to Texas (statistical areas 13–17 combined), 1960–1978.*

	Brown Shrimp			White Shrimp		
Year	c	d	r^2	c	d	r^2
1960	16,792,619	−0.01158	0.982	6,735,954	−0.03286	0.859
1961	9,683,268	−0.01507	0.980	746,104	−0.03511	0.935
1962	7,121,864	−0.00946	0.969	1,989,691	−0.04671	0.851
1963	19,298,733	−0.01274	0.970	22,225,926	−0.05003	0.847
1964	10,538,439	−0.01378	0.874	16,440,034	−0.06129	0.994
1965	16,842,736	−0.00975	0.997	7,148,335	−0.07295	0.986
1966	17,312,685	−0.00957	0.984	10,533,487	−0.05470	0.979
1967	31,665,870	−0.00988	0.979	7,354,846	−0.05329	0.995
1968	23,600,064	−0.00816	0.985	3,793,463	−0.02737	0.957
1969	20,210,847	−0.00425	0.998	7,408,659	−0.04606	0.959
1970	26,922,152	−0.00958	0.969	10,952,300	−0.03839	0.997
1971	30,789,368	−0.00887	0.970	13,765,830	−0.04732	0.995
1972	28,351,769	−0.01058	0.987	9,644,902	−0.05248	0.995
1973	16,561,644	−0.00387	0.996	3,607,660	−0.04251	0.992
1974	17,059,026	−0.00594	0.987	2,836,382	−0.02511	0.912
1975	13,688,820	−0.00535	0.989	4,586,097	−0.03938	0.955
1976	33,812,124	−0.00735	0.987	8,155,067	−0.02722	0.983
1977	48,701,481	−0.01097	0.972	7,897,209	−0.02105	0.984
1978	45,423,493	−0.00804	0.946	9,211,470	−0.04247	0.995

*Based on the linear regression of lnP on C, where P = cumulative weight of May-August catch in each of seven size categories, C = lower limit (count) of each of the seven size categories, ln(c) = intercept, d = slope, and r^2 = coefficient of determination, all slopes, d, were significantly different from 0 at the 99% level of confidence, and the high r^2 values indicated a very good fit of the straight lines to the data points.

was excluded from calculation of the trend for white shrimp from Pensacola to the Mississippi River (Table 11) as in the two previous sections.

Simulations

Models 1 and 2 provided information useful in simulating the impacts of predictable changes in model parameters, barring any major changes in fishery management such as the closure of the FCZ off Texas. We conducted simulations to estimate what the overall average ex-vessel value per pound of the May–August catches of brown and white shrimp in the three coastal areas would have been for selected levels of b , to explore the possible consequences of changes in both the size composition of the catches and the ex-vessel price spread among size categories.

Because there were significant inverse relationships between ln(a) and b for both species in each coastal area (Table 8), we were able to estimate parameter a for selected levels of parameter b for each species and coastal area, to simulate V_i in equation 1. We then calculated the corresponding ex-vessel value per pound by size category from the simulated V_j. In each case, we used the ex-vessel value per pound obtained for the 15–20 size category as an approximation of the minimum ex-vessel value per pound for the < 15 size category, because the model did not encompass the < 15 size category. We then multiplied the simulated ex-vessel value per pound in each size category by the reported pounds caught in each size category to simulate the ex-vessel value of the May–August catches by size category. The weight of catch in the category "pieces" was excluded from these calculations. The resulting values were summed over size categories to simulate the ex-vessel value of the May–August catches (pieces excluded). The simulated ex-vessel value was then divided by the reported May–August catch (pieces excluded) to obtain the simulated May–August average ex-vessel value per pound for each level of b for both species, for each coastal area, and for each year. Straight lines were fitted to the simulated ex-vessel value per pound versus d by linear regression (Table 12, Figures 8 through 13).

An increase in size of shrimp in the catches (as indicated by a decrease in d), coupled with an increase in price spread

TABLE 7.

Relationship between transformed cumulative weight (pounds, heads off) of catch, lnP, and count, C, for reported May–August catches (inshore and offshore combined) of brown and white shrimp from Pensacola to the Mississippi River (statistical areas 10–12 combined), 1960–1978.*

	Brown Shrimp			White Shrimp		
Year	c	d	r^2	c	d	r^2
1960	18,688,894	−0.03557	0.888	1,116,568	−0.01835	0.898
1961	9,525,281	−0.03397	0.932	141,706	−0.02710	0.911
1962	5,783,676	−0.02557	0.877	306,285	−0.03999	0.904
1963	20,786,826	−0.04541	0.895	1,028,879	−0.03534	0.944
1964	10,320,162	−0.02472	0.889	1,610,427	−0.03872	0.941
1965	18,107,921	−0.02888	0.816	575,779	−0.03509	0.923
1966	11,184,171	−0.01133	0.888	531,682	−0.02285	0.884
1967	22,420,583	−0.02483	0.870	816,760	0.02479	0.921
1968	20,390,303	−0.01797	0.884	499,633	−0.02806	0.923
1969	17,867,965	−0.02162	0.861	767,505	−0.03124	0.974
1970	17,263,241	−0.02010	0.890	1,360,986	−0.05002	0.977
1971	19,287,350	−0.01938	0.930	542,037	−0.06344	0.944
1972	14,473,790	−0.01703	0.938	21,844,069†	−0.22577†	0.937
1973	6,980,981	−0.01775	0.948	113,404	−0.04673	0.968
1974	8,348,897	−0.01229	0.929	155,550	−0.02484	0.871
1975	7,967,968	−0.01717	0.890	218,716	−0.03676	0.606
1976	12,660,152	−0.01700	0.882	331,522	−0.02700	0.918
1977	24,861,227	−0.02879	0.888	404,477	−0.02900	0.980
1978	13,224,609	−0.01398	0.874	616,522	−0.04736	0.988

*Based on the linear regression of lnP on C, where P = cumulative weight of May-August catch in each of seven size categories, C = lower limit (count) of each of the seven size categories, ln(c) = intercept, d = slope, and r^2 = coefficient of determination; all slopes, d, were significantly different from 0 at the 99% level of confidence, and the high r^2 values indicated a very good fit of the straight lines to the data points.

†Both c and d for white shrimp in 1972 are distorted because no catch was reported for the ⩾68 count category.

among size categories (as indicated by a decrease in b), clearly results in pronounced increases in the average ex-vessel value per pound for brown and white shrimp (Table 12, Figures 8 through 13). Decreases in b produce greater increases in ex-vessel value per pound than equivalent decreases in d. Because catches also depend upon recruitment each year (Christmas and Etzold 1977), the simulated average ex-vessel value per pound can be used as a multiplier for estimating the ex-vessel value for a given weight of May–August catch of a given size composition, for selected levels of b, for both species, and for each coastal area.

DISCUSSION

The extent to which the exclusion of unreported catches from our analyses affected our results and conclusions cannot be determined. Because reported catches of shrimp are not equivalent to actual catches, and because there are errors in assignment of catches to size categories, size composition of reported catches is not identical to that of actual catches. Unknown portions of catches were not reported, e.g., shrimp discarded because they did not meet minimum size limits or for economic reasons, catches by recreational fishermen, catches sold directly to the consumer, and catches by foreign fishing craft (prior to 1976). Also unknown is the extent of errors of misclassification of catches by size category as a result of shrimp-grading practices. Such misclassification errors may average out in aggregated catches. However, a thorough investigation of the effects of shrimp grading practices ("machine grading" and "box grading") on size distributions of shrimp assigned to various size categories would be necessary to determine the extent and magnitude of misclassification errors.

TABLE 8.

Linear regressions of catch (in millions of pounds, heads off; includes "pieces") on d, and ln(a) on b for reported May–August catches (inshore and offshore combined) of brown and white shrimp from the Texas coast, the Mississippi River to Texas, and Pensacola to the Mississippi River, 1960–1978 (based on data from Tables 1–3 and 5–7).

	Texas Coast		Mississippi River to Texas		Pensacola to Mississippi River	
	Brown Shrimp	White Shrimp	Brown Shrimp	White Shrimp	Brown Shrimp	White Shrimp[1]
For catch on d						
Slope	−20.437	−5.329	586.502	−16.268	48.870	0.874
Intercept	15.3468	1.8985	24.8956	3.6975	9.8000	0.4291
Coefficient of Determination	0.006	0.019	0.035	0.011	0.019	0.002
For ln(a) on b						
Slope	−103.513[2]	−65.392[3]	−95.262[2]	−78.860[2]	−105.387[2]	−70.076[2]
Intercept	−7.3187	−5.1176	−6.7862	−5.7348	−7.0505	−5.2073
Coefficient of Determination	0.495	0.288	0.627	0.509	0.752	0.417

[1] Data for 1972 were excluded (see Tables 3, 4, 7, and 11).
[2] The slope was significantly different from 0 at the 99% level of confidence.
[3] The slope was significantly different from 0 at the 95% level of confidence.

TABLE 9.

Relationship between transformed cumulative ex-vessel value (dollars) of catch, lnD, and count, C, for reported May–August catches (inshore and offshore combined) of brown and white shrimp from the Texas coast (statistical areas 18–21 combined), 1960–1978.*

Year	Brown Shrimp			White Shrimp		
	g	h	r^2	g	h	r^2
1960	108,230,092	−0.11393	0.936	3,736,986	−0.09477	0.805
1961	36,397,112	−0.09024	0.963	1,311,025	−0.05347	0.974
1962	21,729,036	−0.06461	0.924	2,031,327	−0.05238	0.959
1963	45,022,368	−0.09025	0.970	4,415,890	−0.08604	0.955
1964	32,308,471	−0.07813	0.973	3,882,035	−0.06032	0.993
1965	32,423,045	−0.06730	0.964	1,852,691	−0.04951	0.969
1966	45,338,631	−0.07277	0.963	3,972,436	−0.06882	0.953
1967	110,407,652	−0.08742	0.967	1,105,745	−0.04500	0.963
1968	95,090,535	−0.09680	0.932	2,409,621	−0.04215	0.934
1969	52,890,802	−0.07507	0.918	12,070,439	−0.09252	0.989
1970	50,876,414	−0.07431	0.973	9,425,600	−0.07358	0.984
1971	79,798,080	−0.07275	0.947	7,645,440	−0.09942	0.998
1972	161,353,796	−0.08626	0.943	18,067,946	−0.09807	0.970
1973	79,172,534	−0.05277	0.929	7,133,410	−0.04512	0.944
1974	71,254,604	−0.07047	0.975	22,639,800	−0.11129	0.973
1975	88,198,455	−0.05577	0.961	20,209,432	−0.09447	0.992
1976	114,877,856	−0.06065	0.963	12,554,629	−0.05527	0.985
1977	131,374,161	−0.05818	0.969	5,995,621	−0.03921	0.986
1978	82,262,836	−0.04355	0.935	11,590,079	−0.05261	0.963

*Based on the linear regression of lnD on C, where D = cumulative ex-vessel value of May-August catch in each of seven size categories, C = lower limit (count) of each of the seven size categories, ln(g) = intercept, h = slope, and r^2 = coefficient of determination; all slopes, h, were significantly different from 0 at the 99% level of confidence, and the high r^2 values indicated a very good fit of the straight lines to the data points.

TABLE 10.

Relationship between transformed cumulative ex-vessel value (dollars) of catch, lnD, and count, C, for reported May–August catches (inshore and offshore combined) of brown and white shrimp from the Mississippi River to Texas (statistical areas 13–17 combined), 1960–1978.*

Year	Brown Shrimp			White Shrimp		
	g	h	r^2	g	h	r^2
1960	6,294,080	−0.01689	0.984	2,791,110	−0.04070	0.912
1961	4,367,232	−0.02222	0.970	458,704	−0.04443	0.940
1962	3,779,680	−0.01413	0.978	1,465,285	−0.05469	0.890
1963	7,578,910	−0.02356	0.967	12,757,629	−0.06392	0.919
1964	4,030,859	−0.02011	0.932	11,132,619	−0.07464	0.996
1965	7,214,764	−0.01621	0.996	6,237,562	−0.08830	0.986
1966	9,857,173	−0.01814	0.989	10,406,072	0.06669	0.988
1967	13,749,184	−0.01786	0.984	7,436,940	−0.06960	0.993
1968	11,181,487	−0.01686	0.987	3,573,443	−0.04375	0.933
1969	9,291,959	−0.00974	0.990	8,477,109	−0.06181	0.980
1970	13,512,017	−0.01775	0.997	11,711,596	−0.05426	0.997
1971	19,940,033	−0.02048	0.980	22,632,331	−0.07031	0.996
1972	23,692,521	−0.02099	0.992	20,043,390	−0.07449	0.991
1973	16,002,252	−0.00780	0.992	7,756,874	−0.05436	0.992
1974	11,394,827	−0.01407	0.947	4,675,188	−0.04562	0.860
1975	13,595,100	−0.01574	0.971	13,742,173	−0.06326	0.963
1976	45,458,483	−0.01738	0.976	27,191,908	−0.04896	0.978
1977	70,647,268	−0.02095	0.990	16,625,530	−0.03588	0.992
1978	64,185,636	−0.01841	0.974	31,609,871	−0.06042	0.996

*Based on the linear regression of lnD on C, where D = cumulative ex-vessel value of May-August catch in each of seven size categories, C = lower limit (count) of each of the seven size categories, ln(g) = intercept, h = slope, and r^2 = coefficient of determination; all slopes, h, were significantly different from 0 at the 99% level of confidence, and the high r^2 values indicated a very good fit of the straight lines to the data points.

TABLE 11.

Relationship between transformed cumulative ex-vessel value (dollars) of catch, lnD, and count, C, for reported May–August catches (inshore and offshore combined) of brown and white shrimp from Pensacola to the Mississippi River (statistical areas 10–12 combined), 1960–1978.*

Year	Brown Shrimp			White Shrimp			Year	Brown Shrimp			White Shrimp		
	g	h	r^2	g	h	r^2		g	h	r^2	g	h	r^2
1960	8,761,783	−0.04059	0.899	434,369	−0.02356	0.928	1970	10,598,256	−0.02754	0.936	1,304,382	−0.06316	0.985
1961	4,797,953	−0.03877	0.947	74,272	−0.03073	0.921	1971	16,749,182	−0.03108	0.953	964,900	−0.08604	0.945
1962	3,500,583	−0.02976	0.903	222,137	−0.04531	0.913	1972	14,545,322	−0.02534	0.964	44,865,514†	−0.24128†	0.962
1963	10,692,680	−0.05386	0.915	510,773	−0.04643	0.959	1973	10,432,119	−0.02715	0.960	280,896	−0.05838	0.976
1964	4,749,073	−0.03086	0.916	965,547	−0.04960	0.947	1974	7,185,100	−0.02093	0.972	209,025	−0.04113	0.773
1965	9,390,415	−0.03357	0.840	354,339	−0.04205	0.912	1975	12,592,349	−0.02780	0.923	565,050	−0.05625	0.664
1966	6,541,388	−0.01644	0.923	387,472	−0.02925	0.855	1976	22,694,655	−0.02691	0.913	952,133	−0.04408	0.888
1967	11,741,029	−0.03094	0.895	473,568	−0.03479	0.922	1977	47,094,652	−0.03979	0.925	1,127,846	−0.04917	0.979
1968	12,320,437	−0.02614	0.924	395,363	−0.03829	0.951	1978	22,804,307	−0.02376	0.913	2,196,268	−0.06417	0.985
1969	13,085,954	−0.03053	0.897	675,298	−0.03973	0.977							

*Based on the linear regression of lnD on C, where D = cumulative ex-vessel value of May-August catch in each of seven size categories, C = lower limit (count) of each of the seven size categories, ln(g) = intercept, h = slope, and r^2 = coefficient of determination; all slopes, h, were significantly different from 0 at the 99% level of confidence, and the high r^2 values indicated a very good fit of the straight lines to the data points.

†Both g and h for white shrimp in 1972 are distorted because no catch was reported for the $\geq$68 count category.

TABLE 12.

Linear regressions of simulated average ex-vessel value (dollars) per pound (heads off) on d for reported May–August catches (inshore and offshore combined) of brown and white shrimp from the Texas coast, the Mississippi River to Texas, and Pensacola to the Mississippi River, 1960–1978, and for selected levels of b (based on data from Tables 1–3 and 5–8).

			b[1]			
Species	Coastal Area		−0.04	−0.05	−0.06	−0.07
Brown shrimp	Texas coast	Slopes	−0.8265[2]	−2.4952[2]	−6.4834[2]	−15.7231[2]
		Intercepts	0.2918	0.5404	1.0216	1.9686
		Coefficients of determination	0.761	0.724	0.694	0.666
Brown shrimp	Mississippi River to Texas	Slopes	−5.7716[2]	−14.2613[2]	−31.4732[2]	−65.9078[2]
		Intercepts	0.2432	0.3388	0.4837	0.7139
		Coefficients of determination	0.979	0.956	0.930	0.901
Brown shrimp	Pensacola to Mississippi River	Slopes	−3.1418[2]	−8.4739[2]	−20.4354[2]	−46.6675[2]
		Intercepts	0.3214	0.5283	0.8867	1.5235
		Coefficients of determination	0.959	0.956	0.950	0.942
White shrimp	Texas coast	Slopes	−1.4162[2]	−3.2351[2]	−6.1219[2]	−10.6932[2]
		Intercepts	0.5788	0.7834	1.0953	1.5770
		Coefficients of determination	0.745	0.598	0.501	0.433
White shrimp	Mississippi River to Texas	Slopes	−1.8251[2]	−4.8334[2]	−10.5496[2]	−21.2666[2]
		Intercepts	0.5165	0.7830	1.2303	1.9960
		Coefficients of determination	0.723	0.614	0.538	0.484
White shrimp	Pensacola to Mississippi River	Slopes	−3.0922[2]	−8.5463[2]	−18.2301[2]	−35.2227[2]
		Intercepts	0.5750	0.7221	0.9275	1.2195
		Coefficients of determination	0.726	0.557	0.475	0.424

[1] Levels of b selected for the simulations encompassed the observed ranges in b, for the most part.
[2] The slope was significantly different from 0 at the 99% level of confidence.

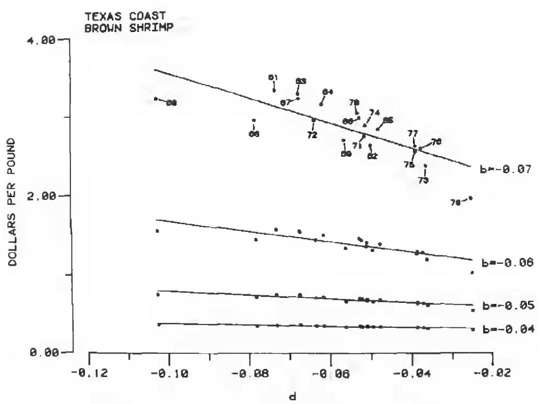

Figure 8. Simulated average ex-vessel value (dollars) per pound (heads off) for reported May–August catches (inshore and offshore combined) of brown shrimp from the Texas coast (statistical areas 18–21 combined), at selected levels of b over the range of d (based on data from Tables 1, 5, and 8). Lines fitted by linear regression (Table 12).

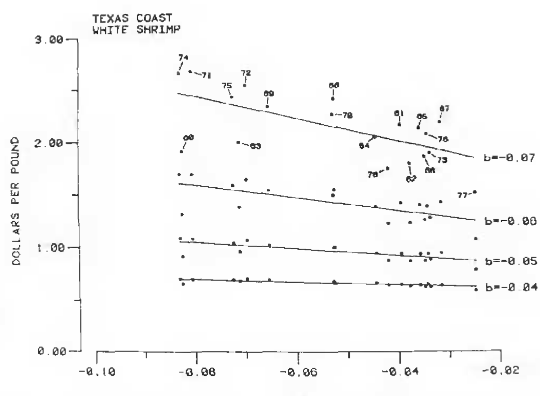

Figure 9. Simulated average ex-vessel value (dollars) per pound (heads off) for reported May–August catches (inshore and offshore combined) of white shrimp from the Texas coast (statistical areas 18–21 combined), at selected levels of b over the range of d (based on data from Tables 1, 5, and 8). Lines fitted by linear regression (Table 12).

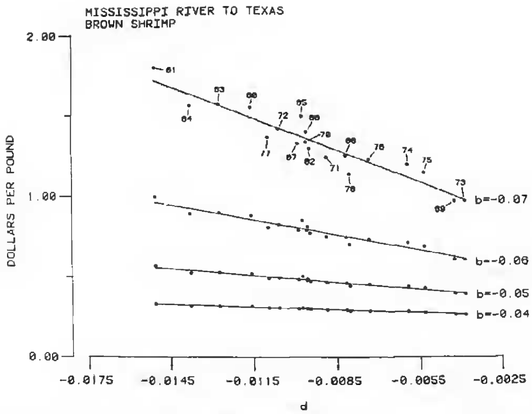

Figure 10. Simulated average ex-vessel value (dollars) per pound (heads off) for reported May–August catches (inshore and offshore combined) of brown shrimp from the Mississippi River to Texas (statistical areas 13–17 combined), at selected levels of b over the range of d (based on data from Tables 2, 6, and 8). Lines fitted by linear regression (Table 12).

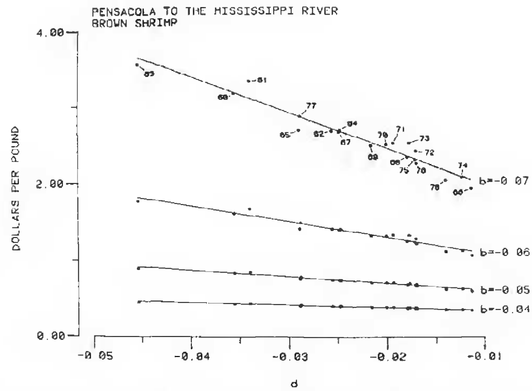

Figure 12. Simulated average ex-vessel value (dollars) per pound (heads off) for reported May–August catches (inshore and offshore combined) of brown shrimp from Pensacola to the Mississippi River (statistical areas 10–12 combined), at selected levels of b over the range of d (based on data from Tables 3, 7, and 8). Lines fitted by linear regression (Table 12).

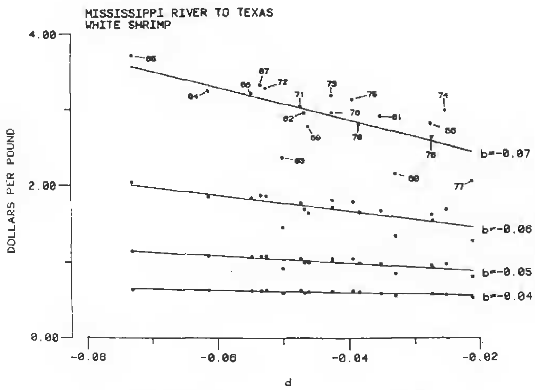

Figure 11. Simulated average ex-vessel value (dollars) per pound (heads off) for reported May–August catches (inshore and offshore combined) of white shrimp from the Mississippi River to Texas (statistical areas 13–17 combined), at selected levels of b over the range of d (based on data from Tables 2, 6, and 8). Lines fitted by linear regression (Table 12).

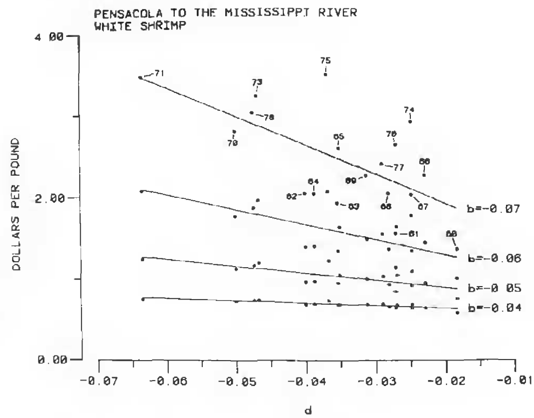

Figure 13. Simulated average ex-vessel value (dollars) per pound (heads off) for reported May–August catches (inshore and offshore combined) of white shrimp from Pensacola to the Mississippi River (statistical areas 10–12 combined), at selected levels of b over the range of d (based on data from Tables 3, 7, and 8). Lines fitted by linear regression (Table 12).

There were significant decreases in size of brown shrimp in the reported May–August catches from the three coastal areas from 1960 to 1978. Caillouet et al. (1980) detected significant decreases in size of brown shrimp in reported annual catches from Texas and Louisiana from 1959 to 1976, and Caillouet and Koi (1980) detected significant decreases in size of brown shrimp in reported annual landings from the northern Gulf from 1961 to 1977. Fishing effort has increased substantially in the northern Gulf coast since 1960 (Christmas and Etzold 1977, GMFMC 1980). For this reason, Caillouet et al. (1980) suggested that the observed decreases in size of brown shrimp may be the effects of increased fishing effort leading to the harvesting of increasing quantities of small shrimp before they grow to larger sizes. However, in the absence of a decline in total catch or conclusive evidence that shrimp are being harvested at rates in excess of that which would maximize yield, this cannot be construed as growth overfishing. The decrease in size of brown shrimp in catches from the Texas coast may be reversed as a result of closure of the FCZ off Texas due to postponement of fishing until the shrimp grow to larger sizes. Coupled with continued increase in the price spread among size categories, an increase in size of brown shrimp in the Texas coast catch could greatly enhance the value of that catch. On the other hand, the closure may increase fishing effort along the coasts of Louisiana, Mississippi, and Alabama (GMFMC 1980), with the possible consequence of exacerbating the trends toward decrease of size of brown shrimp in the catches from these areas. In addition, the increased competition among offshore units could force some of the smaller ones to fish inshore as an alternative, thereby increasing the fishing pressure inshore.

To our surprise, there were no significant changes in size composition of reported May–August catches of white shrimp in the three coastal areas from 1960 to 1978. However, if fishing pressure on the white shrimp stock were increased as a result of closure of the FCZ off Texas, the size of white shrimp in the May–August catch could decrease. Caillouet et al. (1980), and Caillouet and Koi (1980) detected decreases in size of white shrimp in reported annual catches and landings, respectively, from the northern Gulf. Therefore, these decreases in size must have been generated by an overwhelming influence of size composition of the catches during months other than May–August.

Our analyses do not account for the impact of overall inflation on the trends in ex-vessel value of shrimp catches. However, they do indicate that the rate of inflation in ex-vessel value per shrimp is higher for larger than for smaller shrimp, a phenomenon that should be considered in studies of inflationary effects on the ex-vessel value of shrimp catches.

We have characterized the ex-vessel value per shrimp by size category, size composition, and ex-vessel value composition of the reported May–August catches of brown and white shrimp from the Texas, Louisiana, Mississippi, and Alabama coasts from 1960 to 1978. Comparisons, by similar analyses, with catch statistics for 1979, 1980, and 1981, should be of particular use and interest as one means of assessing the impacts of the closure of the FCZ off Texas.

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